

## PATENT ABSTRACTS OF JAPAN

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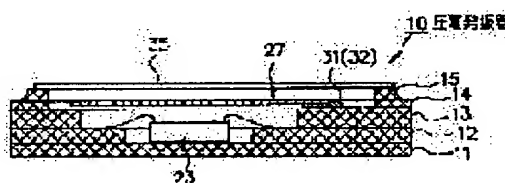
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**(54) PIEZOELECTRIC VIBRATOR, PIEZOELECTRIC OSCILLATOR AND MANUFACTURE OF THEM****(57)Abstract:**

**PROBLEM TO BE SOLVED:** To provide a piezoelectric vibrator and a piezoelectric oscillator with excellent shock resistance performance and where the resistance is suppressed low and no complicated manufacture process causing a cost increase is required and to provide a method for the manufacture of them.

**SOLUTION:** A piezoelectric vibration chip 27 is fixed and supported to an electrode formed to a support 13 with silicon-base conductive adhesive 31, 32. The silicon-base conductive adhesive 31, 32 are cured by increasing the temperature of them and heating them at the temperature rising state that the distribution of conductive particles contained in the adhesives is solidified in a uniform state from preliminary drying to a prescribed curing temperature.

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## CLAIMS

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### [Claim(s)]

[Claim 1] The piezoelectric transducer which has the piezo-electric oscillating piece by which fixed support was carried out with the electric conduction adhesives of a silicon system to the polar zone formed in the base which prepared the polar zone in the front face, and this base, and is characterized by to harden by carrying out temperature up heating in the state of the temperature up which the distribution of the conductive particle which the aforementioned silicon system electric conduction adhesives contain in adhesives from predrying to a predetermined curing temperature solidifies in the uniform state.

[Claim 2] The piezoelectric transducer according to claim 1 by which temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by four Centigrade or more almost per minute from predrying to a predetermined curing temperature.

[Claim 3] The piezoelectric transducer according to claim 1 or 2 by which temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by 7.5 Centigrade almost per minute from predrying to a predetermined curing temperature.

[Claim 4] The piezoelectric transducer according to claim 1 to 3 by which all the adhesion sides of the aforementioned piezo-electric oscillating piece and the aforementioned base to paste up are constituted from aforementioned polar zone.

[Claim 5] The piezoelectric transducer according to claim 1 to 4 in which the aforementioned polar zone is formed with gold or silver.

[Claim 6] It is the piezoelectric transducer according to claim 1 to 5 which the aforementioned silicon system electric conduction adhesives are applied to the field between the aforementioned base and a piezo-electric oscillating piece, and is constituted so that it may not be applied to the field where the base of a piezo-electric oscillating piece is opposite.

[Claim 7] As opposed to the base which prepared a predetermined electric conduction pattern and the predetermined polar zone in the front face, the integrated circuit by which connection fixation was electrically carried out with the electric conduction pattern of the aforementioned base, and the polar zone formed in the aforementioned base It has the piezo-electric oscillating piece by which fixed support was carried out with the electric conduction adhesives of a silicon system, the aforementioned silicon system electric conduction adhesives from predrying to a predetermined curing temperature The piezo oscillator characterized by hardening by carrying out temperature up heating in the state of the temperature up which the distribution of the conductive particle contained in adhesives solidifies in the uniform state.

[Claim 8] The piezo oscillator according to claim 7 by which temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by four Centigrade or more almost per minute from predrying to a predetermined curing temperature.

[Claim 9] The piezo oscillator according to claim 7 or 8 by which temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by 7.5 Centigrade almost per minute from predrying to a predetermined curing temperature.

[Claim 10] The piezo oscillator according to claim 7 to 9 by which all the adhesion sides of the aforementioned piezo-electric oscillating piece and the aforementioned base to paste up are constituted from aforementioned polar zone.

[Claim 11] The piezo oscillator according to claim 7 to 10 in which the aforementioned polar zone is formed with gold or silver.

[Claim 12] It is the piezo oscillator according to claim 7 to 11 which the aforementioned silicon system electric conduction adhesives are applied to the field between the aforementioned base and a piezo-electric oscillating piece, and is constituted so that it may not be applied to the field where the base of a piezo-electric oscillating piece is opposite.

[Claim 13] The manufacture method of a piezoelectric transducer characterized by to have the hardening process by which temperature-up heating is carried out in the state of the temperature up which the distribution of the conductive particle which the aforementioned silicon system electric-conduction adhesives contain in adhesives from predrying to a predetermined curing temperature solidifies in a uniform state in the manufacture method of the piezoelectric transducer equipped with the process which fixes a piezo-electric oscillating piece with the electric-conduction adhesives of a silicon system to the polar zone formed in the base made from a ceramic.

[Claim 14] As opposed to the polar zone which formed the supporter made from a ceramic in this base section, one, or another object at the base section made from a ceramic by which the electric conduction pattern was formed in the front face, and was formed in the supporter made from this ceramic In the manufacture method of a piezo oscillator including the process which fixes a piezo-electric oscillating piece with the electric conduction adhesives of a silicon system the aforementioned silicon system electric conduction adhesives from predrying to a predetermined curing temperature The manufacture method of a piezo oscillator characterized by having the hardening process which carries out temperature up heating in the state of the temperature up which the distribution of the conductive particle contained in adhesives solidifies in the uniform state.

### DETAILED DESCRIPTION



[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] this invention relates to improvement of the piezoelectric transducer constituted using a piezo-electric oscillating piece, and the piezo oscillator which carried this piezoelectric transducer.

[0002]

[Description of the Prior Art] Conventionally, such a piezoelectric transducer is constituted as shown in drawing 18.

[0003] In drawing, the piezoelectric transducer 1 formed the electric conduction pattern 2 in the upper surface of the base section 8 made from a ceramic, and is equipped with the susceptor 3 fixed with a silver paste on it. Electrodes 7 and 7 are formed in the upper surface of this susceptor 3, and the piezo-electric oscillating piece 4 is being fixed to the upper surface of a susceptor 3. The external electrodes 6 and 6 are formed in the piezo-electric oscillating piece 4, these electrodes 6 and 6 are electrically connected with the above-mentioned electric conduction pattern 2 of the base section 8 through the electrodes 7 and 7 of a susceptor 3, and this electric conduction pattern 2 is led to the background of the base section 8, and is connected with the exterior. And it is closed by putting a cap 5 so that the piezo-electric oscillating piece 4 may be covered from a top.

[0004] According to such a piezoelectric transducer 1, by the ability giving predetermined drive current from the outside, when the piezo-electric oscillating piece 4 vibrates with peculiar vibration frequency and takes this out electrically, the current of predetermined frequency can be acquired. By combining this with a predetermined oscillator circuit, the clock signal of a computer, the reference clock of a clock, etc. can be obtained.

[0005] And the piezo oscillator which combined the oscillator circuit which had the above-mentioned piezoelectric transducer integrated is also used widely.

[0006]

[Problem(s) to be Solved by the Invention] By the way, in the electric flow, if it is in the above piezoelectric transducers 1, since the piezo-electric oscillating piece 4 is held to the base section 8 or a susceptor 3 and it fixes the electroconductive glue is used.

[0007] What becomes with silicon resin, conductive silver dust, and a solvent as such an electroconductive glue is used widely. By using such adhesives, adhesion fixation is performed simply, securing a flow.

[0008] However, as shown in drawing 19, various devices are performed, in order that the adhesives of a silicon system may obtain a mechanical strength required for a product, since the bond strength is weak as compared with other adhesives.

[0009] For example, the outcrop of the crystal chip which constitutes a piezo-electric oscillating piece is enlarged, or the outcrop of the base section is enlarged, and it is made for these outcrops to constitute a part of adhesion side by adhesives according to JP,8-139426,A. According to this, a bond strength can be raised as compared with the case where only the polar zone is pasted with the application of adhesives.

[0010] However, if it does in this way, the area of the polar zone which should be inevitably formed in a piezo-electric oscillating piece will become small. For this reason, if drive power becomes small about [ 0.01micro ] with W, the equivalent-series-resistance value (crystal impedance) (henceforth "CI value") of the piezo-electric oscillating piece 4 made from crystal will become large, and the crystal oscillating piece 4 will stop being able to vibrate easily. That is, there is a fault in which the drive level of a piezoelectric transducer gets worse. Therefore, if it is going to raise drive level, with the polar zone narrowed, it will be necessary to thicken the electrode layer which forms the polar zone.

[0011] Here, if it is going to thicken an electrode layer, electrode formation time will become long, expensive target material and the source of vacuum evaporation will be consumed so much, and a manufacturing cost will rise. Moreover, when a product is miniaturized, it will be necessary to solve the technical problem of another many, such as improvement in the loading precision of a crystal oscillating piece, or the positioning accuracy of an adhesion position, and proper quantity management of adhesives.

[0012] Moreover, in case a crystal oscillating piece is pasted up as an option as indicated by JP,2-75214,A and JP,5-25822,U, the high adhesives of not only silicon system electric conduction adhesives but other bond strengths are used, and the method of compensating an insufficient bond strength is also considered to be the above. However, when two or more kinds of adhesives are used in this way, the part-manufacturing process becomes complicated and there is a fault which causes elevation of a manufacturing cost from the increase in a man day.

[0013] On the other hand, according to the patent No. 2668585, as shown in drawing 20, for example It is contracting adhesives 9 in the process which applies even to the field of an opposite side in the supporter 3 of the piezo-electric oscillating piece 4, and adhesives' 9 harden by this, in case the piezo-electric oscillating piece's 4 is pasted up to the supporter 3 on the base section 8. The fixed-end section and the opposite side of the piezo-electric oscillating piece 4 are floated, and the attempt which is going to ease stress also occurs as shown in the arrow.

[0014] However, since adhesives 9 will be applied even to the upper surface side of the piezo-electric oscillating piece 4 of drawing 20 in this case, the product size becomes thick and serves as small [ of a product ], and an



obstacle of thin-shape-izing.

[0015] Moreover, configurations, such as a supporter, are devised and a device which raises a bond strength is also tried so that the amount of the adhesives to apply may be made [ many ] unlike these and adhesives may not short-circuit electrodes in that case. There are JP,4-119126,U. JP,7-74576,A. JP,7-240653,A. JP,5-48369,A, etc. in this kind of technology. It is made to miss these adhesives in this, so that Slots 3b and 3b may be formed in the upper surface of a susceptor 3, the side slots 3a and 3a may be formed further and the adhesives applied so much may not short-circuit electrodes 6 and 6 as JP,5-48369.A shows to drawing 21 .

[0016] However, in order [ these ] to miss adhesives, when a slot etc. is formed like, stress concentration tends to happen structurally and the portion has risk of the rapid temperature rise in the case of closure breaking.

[0017] It aims at offering the piezoelectric transducers and piezo oscillators which do not need a complicated manufacturing process which causes elevation of cost, and these manufacture methods while this invention was made in order to solve an above-mentioned technical problem, it is excellent in shock-proof ability and moreover holds down resistance low.

[0018]

[Means for Solving the Problem] For this reason, the piezoelectric transducer of invention of a claim 1 has the piezo-electric oscillating piece by which fixed support was carried out with the electric conduction adhesives of a silicon system to the supporter which prepared the polar zone in the front face, and the polar zone formed in this supporter, and is hardened by carrying out temperature up heating in the state of the temperature up which the distribution of the conductive particle which the aforementioned silicon system electric conduction adhesives contain in adhesives from predrying to a predetermined curing temperature solidifies in the uniform state.

[0019] According to the composition of a claim 1, temperature up heating of the distribution of the conductive particle which the electric conduction adhesives of the silicon system which pastes up a supporter and a piezo-electric oscillating piece contain in adhesives from predrying to a predetermined curing temperature is carried out in the state of the temperature up solidified in the uniform state. Here, this invention person etc. found out that the heating up time and resistance for hardening of the electric conduction adhesives of a silicon system had the next relation.

[0020] When silicon system electric conduction adhesives were distributed unevenly and the conductive particle which adhesives contain, for example, silver dust, and silicon resin hardened them in the process of hardening, the thing [ state / rough \*\*\*\*\* / that is, ] which silver dust rises in the part of a low state, and resistance rises / density / became clear. That is, in the process of hardening, silicon resin contracts silicon system electric conduction adhesives with evaporation of a solvent. In the process of this contraction, silicon resin carries out the operation which brings in a conductive particle in the contraction direction. For this reason, if the setting time is comparatively long, it will concentrate near the center of adhesives and a conductive particle will be solidified in the densities of a surrounding resin, or the state where it waited.

[0021] Then, the hardening heating up time of silicon system electric conduction adhesives is measured beforehand, and it is made to harden by such heating up time so that there may be no such thing. Thereby, while suppressing elevation of resistance, a required bond strength is obtained.

[0022] According to invention of a claim 2, in the composition of a claim 1, it constitutes so that temperature up heating of the aforementioned silicon system electric conduction adhesives may be carried out by four Centigrade or more almost per minute from predrying to a predetermined curing temperature.

[0023] in order to acquire the effect of a claim 1 according to the composition of a claim 2, the heating up time checked [ person / this invention ] is 4 or more degree of Centigrade almost per minute to a desirable curing temperature predetermined from predrying

[0024] According to invention of a claim 3, in the composition of claims 1 or 2, it constitutes so that temperature up heating of the aforementioned silicon system electric conduction adhesives may be carried out by 7.5 Centigrade almost per minute from predrying to a predetermined curing temperature.

[0025] in order to acquire the effect of a claim 1 according to the composition of a claim 3, a heating up time applicable to the various quality of an adhesion facing is Centigrade 7.5 degree almost per minute to a desirable curing temperature predetermined from predrying

[0026] Moreover, according to invention of a claim 4, in the composition of a claim 1 or either of 3, all the adhesion sides of the aforementioned piezo-electric oscillating piece and the aforementioned supporter to paste up consist of aforementioned polar zone.

[0027] According to the composition of a claim 4, bond strength sufficient also as a field in which the electrode is formed in the whole of the adhesion side by stiffening silicon system electric conduction adhesives on condition that a claim 1 or 3 is obtained. Moreover, for this reason, resistance cannot be unnecessarily raised from a bird clapper as it is unnecessary to narrow the polar zone superfluously, and resistance can be held down sufficiently low.

[0028] According to invention of a claim 5, in a claim 1 or the composition of 4, the aforementioned polar zone is formed with gold or silver.

[0029] According to the composition of a claim 5, compared with other materials, resistance can be held down low, and efficient equipment can consist of using the polar zone as gold (Au) or silver (Ag). a programming rate [ in / a hardening process / as shown in drawing 22 here / in silicon system electric conduction adhesives ] --



usual conditions like Centigrade 2 or about 3 times per minute -- setting -- a relation with the quality of the material of an adhesion side -- hardening reaction time -- things -- \*\* In this case, since a hardening heating up time can be stiffened in short time also to the adhesion side which becomes with gold (Au) or silver (Ag) by considering as the conditions of a claim 1 or either of 4 unlike drawing 22, adhesives harden unevenly also as such an adhesion side, and resistance is not raised.

[0030] Moreover, it is constituted so that the aforementioned silicon system electric conduction adhesives may be applied to the field between the aforementioned base and a piezo-electric oscillating piece and invention of a claim 6 may not be applied to the field where the base of a piezo-electric oscillating piece is opposite in a claim 1 or the composition of 5.

[0031] Moreover, the base section by which the electric conduction pattern was formed in the front face if it was in invention of a claim 7. As opposed to the supporter which has been arranged on this base section and prepared the polar zone in the front face, and the polar zone formed in the aforementioned supporter It has the piezo-electric oscillating piece by which fixed support was carried out with the electric conduction adhesives of a silicon system, and the integrated circuit electrically connected with the electric conduction pattern of the aforementioned base section, the aforementioned silicon system electric conduction adhesives from predrying to a predetermined curing temperature It is the piezo oscillator hardened by carrying out temperature up heating in the state of the temperature up which the distribution of the conductive particle contained in adhesives solidifies in the uniform state.

[0032] According to the composition of a claim 7, it becomes possible to give sufficient bond strength, without raising resistance about the electric conduction adhesives of a silicon system by the same principle as the case of a claim 1.

[0033] According to invention of a claim 8, in the composition of a claim 7, temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by four Centigrade or more almost per minute from predrying to a predetermined curing temperature.

[0034] According to invention of a claim 9, in the composition of claims 7 or 8, temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by 7.5 Centigrade almost per minute from predrying to a predetermined curing temperature.

[0035] According to invention of a claim 10, in a claim 7 or the composition of 9, all the adhesion sides of the aforementioned piezo-electric oscillating piece and the aforementioned supporter to paste up consist of aforementioned polar zone.

[0036] According to invention of a claim 11, in a claim 7 or the composition of 10, the aforementioned jointing is formed with gold or silver.

[0037] According to invention of a claim 12, the aforementioned silicon system electric conduction adhesives are applied to the field between the aforementioned base and a piezo-electric oscillating piece, and the base of a piezo-electric oscillating piece is a piezo oscillator constituted so that it may not be applied to an opposite field.

[0038] According to invention of a claim 13, in the manufacture method of a piezoelectric transducer equipped with the process which fixes a piezo-electric oscillating piece with the electric conduction adhesives of a silicon system, the distribution of the conductive particle which the aforementioned silicon system electric conduction adhesives contain in adhesives from predrying to a predetermined curing temperature is equipped with the hardening process by which temperature up heating is carried out in the state of the temperature up solidified in the uniform state to the polar zone formed in the supporter made from a ceramic.

[0039] According to the composition of a claim 13, the piezoelectric transducer equipped with the operation by the claim 1 can be manufactured suitably.

[0040] As opposed to the polar zone which according to invention of a claim 14 formed the supporter made from a ceramic in this base section, one, or another object at the base section made from a ceramic by which the electric conduction pattern was formed in the front face, and was formed in the supporter made from this ceramic In the manufacture method of a piezo oscillator equipped with the process which fixes a piezo-electric oscillating piece with the electric conduction adhesives of a silicon system the aforementioned silicon system electric conduction adhesives from predrying to a predetermined curing temperature In the state of the temperature up solidified in the uniform state, the distribution of the conductive particle contained in adhesives is equipped with the hardening process which carries out temperature up heating.

[0041] According to the composition of a claim 14, the piezo oscillator equipped with the operation by the claim 6 can be manufactured suitably.

[0042]

[Embodiments of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained, referring to a drawing.

[0043] Drawing 1 or drawing 12 shows the manufacture process of the piezo oscillator concerning the operation gestalt of this invention, by explaining the process one by one, is united and explains the composition.

[0044] For drawing 1, the plan of the first process and drawing 2 are [ a bottom plan view and drawing 4 of the A-A cross section and drawing 3 ] the right lateral views of drawing 1.

[0045] In these drawings, on the base section 11 which is a plate made from a ceramic, the supporter material 12, 13, and 14 made from a ceramic carried out the laminating, and fixed one by one, and the metal seal ring 15 has fixed by silver soldering in the periphery section of the supporter material 14 further. The whole lower unit



of a piezo-electric radiator is called base 40 here, and suppose this base 40 that the whole thing which carried out the laminating of the supporter material 12, 13, and 14, and fixed on the above-mentioned base section 11 is put. And although this base 40 fixed the supporter material of above another objects in the base section 11, it may form the whole with the ceramic material of the base section 11 and one etc., without using others and supporter material.

[0046] The electric conduction pattern 16 with which the integrated circuit later mentioned near [ the ] a center is laid and fixed is formed in the upper surface of the base section 11 as shown in drawing 1 . The electric conduction pattern of this operation gestalt makes electric resistance small, and is formed with the gold (Au) which cannot do an oxide film easily. Specifically, the tungsten was printed upwards, electrolysis plating of the nickel (nickel) is carried out, further, in 0.5 or thickness of 1.27 micrometers, electrolysis plating is carried out and gold is constituted. Here, nickel plating is performed for increasing a golden bond strength. Moreover, although corrosion resistance falls a little rather than gold, you may form an electric conduction pattern with silver (Ag) for the same reason as gold.

[0047] The electric conduction pattern 21 is formed in the background of the base section 11, and it connects with the exterior at it as shown in drawing 3 .

[0048] As shown in drawing 2 , the supporter material 12 which fixes on the base section 11 is made into a configuration which forms the space S1 of a size in which the integrated circuit mentioned later inside can be held. The electric conduction patterns 17 and 18 with which wirebonding of the end-connection child of the above-mentioned integrated circuit should be carried out are formed in the upper surface of this supporter material 12. Moreover, the supporter material 13 is made into the configuration which forms space S2 in the interior. In drawing of this supporter material 13, as shown in drawing 1 , the polar zone 19 and 20 formed by the electric conduction pattern by gold plate etc. is formed in the right-hand side upper surface. Furthermore, the supporter material 14 is made into a configuration which forms space S3 inside, and the above-mentioned seal ring 15 has fixed in the periphery section of the upper surface of this supporter material 14.

[0049] Next, as shown in drawing 5 and drawing 6 , an integrated circuit 23 is fixed by die bonding etc. with adhesives 26 on the electric conduction pattern 16 of the base section 11. The integrated circuit 23 is held in space S1 as shown in drawing 6 .

[0050] Subsequently, wirebonding of each electric conduction patterns 17 and 18 which correspond with the end-connection child 25 of an integrated circuit 23 is carried out to drawing 7 and drawing 8 by the gold streak 24, and it connects with them electrically as shown. The connected gold streak 24 is held in space S2 as illustrated.

[0051] Next, as shown in drawing 9 and drawing 10 , a piezo-electric oscillating piece is fixed to the supporter material 13. In this case, the piezo-electric oscillating piece consists of crystal oscillating pieces 27 using crystal. An electrode 28 and an electrode 29 as shown in drawing 9 are beforehand formed in this crystal oscillating piece 27 of vacuum evaporation etc. In drawing 9 , in the edge of the cross direction of the crystal oscillating piece 27, it turns and each electrodes 28 and 29 are formed so that a background may be followed. That is, in drawing 10 , it is continuously formed so that it may expose to the right end subordinate side of the crystal oscillating piece 27.

[0052] And as shown in drawing 9 and drawing 10 , as the silicon system electric conduction binders 31 and 32 are applied on each polar zone 19 and 20 of the supporter material 13 and the crystal oscillating piece 27 is laid on it, the silicon system electric conduction binders 31 and 32 are stiffened, and it fixes. Therefore, all the adhesion sides of the supporter material 13 and the crystal oscillating piece 27 are polar zone in this case.

[0053] Moreover, it can avoid applying the silicon system electric conduction binders 31 and 32 to the upper surface of the crystal oscillating piece 27 which is the field of an opposite side in the supporter material 13 preferably. By considering as such structure, thickness of a product can be made thin. And since the amount of the adhesives to be used can be lessened, it can prevent changing the property of a piezoelectric transducer by the gas which occurs from adhesives.

[0054] Here, FA-730 of FUJIKURA KASEI CO., LTD. were used for the silicon system electric conduction binders 31 and 32. These adhesives consist of silver dust of an unfixed configuration, and silicon resin and an aromatic system hydrocarbon system solvent as a conductive particle, and the composition is a weight ratio and is 17.7% of silicon resin, 71.0% of silver dust, and 11.3% of solvents.

[0055] Moreover, a silicon system electric conduction binder can use suitably 3303 made from other, for example incorporated company, three bond [ above ], and the TSE3212 grade of Toshiba Silicone.

[0056] Dryness and hardening of the silicon system electric conduction binders 31 and 32 were performed in the process shown in drawing 13 using the belt furnace. First, as predrying, the temperature up of the ambient temperature is carried out to 65-degree Centigrade, at 65-degree Centigrade or 75 degrees, heating is carried out for about 20 minutes (plus 5-minute minus 0 minute), and a solvent is volatilized enough. Next, a temperature up is carried out to 190 or less degrees 180 degrees or more at the temperature up speed for /7.5-degree Centigrade, and heating was carried out for about 60 minutes (plus 5-minute minus 0 minute), and it was made to have considered belt speed as a part for about 9mm/, and to harden.

[0057] This hardening process is important especially in this operation gestalt. Silicon system electric conduction adhesives can do the conditions which a conductive particle hardens in the state of existing in homogeneity mostly, in silicon resin because it is contingent [ on a fixed heating up time ] to a curing



temperature after above-mentioned predrying. While being able to obtain the suitable flow performance by this, when a mechanical strength equalized, it became clear that a sufficiently strong bond strength is obtained. [0058] Moreover, bond strength sufficient as an adhesion side, by adopting such a hardening process when the polar zone is used as mentioned above is obtained. That is, polar zone 19 and 20 is based on gold or silver as mentioned above, and plating processing is carried out. If adhesives like this operation gestalt are used only on condition that usual when such an electrode side is made into an adhesion side, as drawing 22 explained, the reaction time in an interface will become comparatively long. And if a hardening reaction takes a long time, a conductive particle will be led to the center of adhesives and density will become thin in an interface. However, since the process stiffened in the above short heating up times was established after predrying, a hardening reaction rate can be brought forward at the hardening process of this operation gestalt also as an adhesion side, and it can be made to harden the above electrode sides, after the conductive particle has existed uniformly in silicon resin. It is possible to obtain bond strength sufficient with a small amount of adhesives, without taking the structure where the means which misses fluids, such as a slot, to a supporter is formed like before, and the short circuit of polar zone 19 and 20 is avoided by this. And flow performance sufficient by using all adhesion sides as an electrode can be obtained, and it is possible to lower resistance enough from a good thing in respect of the electrode of gold or silver especially. And like before, the part and polar zone which do not form the means of the slot on the supporter etc. can secure sufficient area, and can obtain the flow function which was excellent also in this point. Moreover, since external force etc. has not established the structurally weak part which carries out stress concentration in a hoe \*\*\*\*\* case in order not to form the means of a slot etc. in supporter material, a product strong against the part structure target is obtained. Moreover, a product with the small size of the part cross direction is obtained by not forming the means of a slot etc. in supporter material in this way. Here, as a result of this invention person's etc. trying the heating up time after this predrying variously, when obtaining sufficient low resistance and a sufficient bond strength, it was checked per minute as a heating up time (programming rate) that four Centigrade or more is required in the range of dispersion on the quality of a silicon system electric conduction binder. Moreover, especially as this heating up time, it was five Centigrade or more per minute, and in the effect, it could consider as the range of the tolerance which is satisfactory practically, and the result most stabilized in 7.5 Centigrade per minute was obtained. In addition, although the earlier one is desirable, the temperature up speed of ten or less Centigrade is suitable [ from the present technical restrictions ] about the programming rate, per minute as an upper limit.

[0059] Next, as it heats by 200-degree Centigrade for about 2 hours, the crystal oscillating piece 27 is aged and it is shown in drawing 11 and drawing 12, it closes by stationing and carrying out the seam welding of the cap 35 made from covar who performed nickel plating beforehand on a seal ring 15, and a piezo oscillator 10 is completed.

[0060] Drawing 14 is the outline cross section showing the operation gestalt of the piezoelectric transducer of this invention, and since the part which attached the same sign as having used it in explanation of the above-mentioned piezo oscillator 10 is the almost same composition, the overlapping explanation is omitted and is hereafter explained focusing on difference.

[0061] In drawing, as the piezoelectric transducer 50 has the piezo-electric oscillating piece 27 fixed to the supporter material 13 and 14 and this supporter material 14 made from the ceramic which fixed one by one on the base section 11 which becomes by the substrate made from a ceramic, and this base section 11 and covers this piezo-electric oscillating piece 27, through the seal ring 15, it stations a cap 35, closes and is formed on the supporter material 13.

[0062] And the supporter 13 and the piezo-electric oscillating piece 27 are pasted up with the ceramic system electric conduction adhesives 31 and 32 according to the same process as the piezo oscillator 10 mentioned above.

[0063] Thereby, also in this piezoelectric transducer 50, the completely same effect as the piezo oscillator 10 mentioned above can be acquired.

[0064] In addition, the supporter material 13 and 14 may be constituted by the base section 11 and one by the same material.

[0065] About the piezoelectric transducer 50 constituted according to each above-mentioned operation gestalt, in order to check the resistance, the result which measured CI value is shown in drawing 15.

[0066] Using the terminal electrode of the end face of the base section 11, drawing 15 impresses drive current, changes the power from 0.01microW to 100microW, measures CI value of 41 places, and shows deltaCI which becomes drawing 15 (a) at the CI maximum minus CI minimum value about a maximum CI value at drawing 15 (b). In the case of the piezoelectric transducer 50 manufactured by the above-mentioned method, the thing of low resistance was able to be obtained enough.

[0067] Moreover, drawing 16 and drawing 17 performed the drop test for investigating the shock resistance about the piezoelectric transducer 50 constituted according to the above-mentioned operation gestalt. Drawing 16 measured CI value before fall, and CI value after fall in each fall height of a horizontal axis, sample each was asked for the difference and CI value was measured with 100microW drive current. Drawing 17 measures how much after the frequency of the product before fall falling, it changed in each fall height of a horizontal axis.

[0068] Thus, in the piezoelectric transducer 50 by this operation gestalt, it has the shock resistance excellent not only in the mechanical strength but the performance side about shock resistance.



[0069] In addition, the property about the above-mentioned piezoelectric transducer 50 cannot be overemphasized by the same thing in a piezo oscillator 10.

[0070]

[Effect of the Invention] As explained above, while according to invention of a claim 1 and a claim 7 excelling in shock-proof ability and holding down resistance low moreover, the piezoelectric transducer and piezo oscillator which do not need a complicated manufacturing process which causes elevation of cost can be offered, respectively.

[0071] the conditions that it is desirable respectively in order to acquire the effect of a claim 1 and a claim 7 according to invention of a claim 2 and a claim 8 can be offered, and according to invention of a claim 3 and a claim 9, in order to acquire the effect which are a claim 1 and a claim 7, still more desirable conditions can be offered

[0072] According to invention of a claim 4 and a claim 10, in addition to the effect of a claim 1 or a claim 6, a piezoelectric transducer or a piezo oscillator excellent in the flow performance can be offered, without spoiling a bond strength.

[0073] According to invention of a claim 5 and a claim 11, in addition to the effect of a claim 1 or a claim 6, a piezoelectric transducer or a piezo oscillator excellent in the low flow performance of resistance can be offered, without spoiling a bond strength.

[0074] According to invention of a claim 6 and a claim 12, since there are no adhesives on a piezo-electric oscillating piece, a piezoelectric transducer or a piezo oscillator with the thin part thickness can be offered.

[0075] While according to invention of a claim 11 and a claim 12 being able to obtain sufficient bond strength and holding down resistance low moreover, the manufacture method of of the piezoelectric transducer and piezo oscillator which do not need a complicated manufacturing process which causes elevation of cost can be offered, respectively.

## TECHNICAL FIELD

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[The technical field to which invention belongs] this invention relates to improvement of the piezoelectric transducer constituted using a piezo-electric oscillating piece, and the piezo oscillator which carried this piezoelectric transducer.

## PRIOR ART

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[Description of the Prior Art] Conventionally, such a piezoelectric transducer is constituted as shown in drawing 18.

[0003] In drawing, the piezoelectric transducer 1 formed the electric conduction pattern 2 in the upper surface of the base section 8 made from a ceramic, and is equipped with the susceptor 3 fixed with a silver paste on it. Electrodes 7 and 7 are formed in the upper surface of this susceptor 3, and the piezo-electric oscillating piece 4 is being fixed to the upper surface of a susceptor 3. The external electrodes 6 and 6 are formed in the piezo-electric oscillating piece 4, these electrodes 6 and 6 are electrically connected with the above-mentioned electric conduction pattern 2 of the base section 8 through the electrodes 7 and 7 of a susceptor 3, and this electric conduction pattern 2 is led to the background of the base section 8, and is connected with the exterior. And it is closed by putting a cap 5 so that the piezo-electric oscillating piece 4 may be covered from a top.

[0004] According to such a piezoelectric transducer 1, by the ability giving predetermined drive current from the outside, when the piezo-electric oscillating piece 4 vibrates with peculiar vibration frequency and takes this out electrically, the current of predetermined frequency can be acquired. By combining this with a predetermined oscillator circuit, the clock signal of a computer, the reference clock of a clock, etc. can be obtained.

[0005] And the piezo oscillator which combined the oscillator circuit which had the above-mentioned piezoelectric transducer integrated is also used widely.

## EFFECT OF THE INVENTION

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[Effect of the Invention] As explained above, while according to invention of a claim 1 and a claim 7 excelling in shock-proof ability and holding down resistance low moreover, the piezoelectric transducer and piezo oscillator which do not need a complicated manufacturing process which causes the rise of cost can be offered, respectively.

[0071] the conditions that it is desirable respectively in order to acquire the effect of a claim 1 and a claim 7 according to invention of a claim 2 and a claim 8 can be offered, and according to invention of a claim 3 and a claim 9, in order to acquire the effect which are a claim 1 and a claim 7, still more desirable conditions can be offered

[0072] According to invention of a claim 4 and a claim 10, in addition to the effect of a claim 1 or a claim 6, a piezoelectric transducer or a piezo oscillator excellent in the flow performance can be offered, without spoiling a bond strength.



[0073] According to invention of a claim 5 and a claim 11, in addition to the effect of a claim 1 or a claim 6, a piezoelectric transducer or a piezo oscillator excellent in the low flow performance of resistance can be offered, without spoiling a bond strength.

[0074] According to invention of a claim 6 and a claim 12, since there are no adhesives on a piezo-electric oscillating piece, a piezoelectric transducer or a piezo oscillator with the thin part thickness can be offered.

[0075] While according to invention of a claim 11 and a claim 12 being able to obtain sufficient bond strength and holding down resistance low moreover, the manufacture method of of the piezoelectric transducer and piezo oscillator which do not need a complicated manufacturing process which causes the rise of cost can be offered, respectively.

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## TECHNICAL PROBLEM

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[Problem(s) to be Solved by the Invention] By the way, in the electric flow, if it is in the above piezoelectric transducers 1, since the piezo-electric oscillating piece 4 is held to the base section 8 or a susceptor 3 and it fixes the electroconductive glue is used.

[0007] What becomes with silicon resin, conductive silver dust, and a solvent as such an electroconductive glue is used widely. By using such adhesives, adhesion fixation is performed simply, securing a flow.

[0008] However, as shown in drawing 19, various devices are performed, in order that the adhesives of a silicon system may obtain a mechanical strength required for a product, since the bond strength is weak as compared with other adhesives.

[0009] For example, the outcrop of the crystal chip which constitutes a piezo-electric oscillating piece is enlarged, or the outcrop of the base section is enlarged, and it is made for these outcrops to constitute a part of adhesion side by adhesives according to JP,8-139426,A. According to this, a bond strength can be raised as compared with the case where only the polar zone is pasted with the application of adhesives.

[0010] However, if it does in this way, the area of the polar zone which should be inevitably formed in a piezo-electric oscillating piece will become small. For this reason, if drive power becomes small about [ 0.01micro ] with W, the equivalent-series-resistance value (crystal impedance) (henceforth "CI value") of the piezo-electric oscillating piece 4 made from crystal will become large, and the crystal oscillating piece 4 will stop being able to vibrate easily. That is, there is a fault in which the drive level of a piezoelectric transducer gets worse. Therefore, if it is going to raise drive level, with the polar zone narrowed, it will be necessary to thicken the electrode layer which forms the polar zone.

[0011] Here, if it is going to thicken an electrode layer, electrode formation time will become long, expensive target material and the source of vacuum evaporation will be consumed so much, and a manufacturing cost will rise. Moreover, when a product is miniaturized, it will be necessary to solve the technical problem of another many, such as improvement in the loading precision of a crystal oscillating piece, or the positioning accuracy of an adhesion position, and proper quantity management of adhesives.

[0012] Moreover, in case a crystal oscillating piece is pasted up as an option as indicated by JP,2-75214,A and JP,5-25822,U, the high adhesives of not only silicon system electric conduction adhesives but other bond strengths are used, and the method of compensating an insufficient bond strength is also considered to be the above. However, when two or more kinds of adhesives are used in this way, the part manufacturing process becomes complicated and there is a fault which causes elevation of a manufacturing cost from the increase in a man day.

[0013] On the other hand, according to the patent No. 2668585, as shown in drawing 20, for example It is contracting adhesives 9 in the process which applies even to the field of an opposite side in the supporter 3 of the piezo-electric oscillating piece 4, and adhesives' 9 harden by this, in case the piezo-electric oscillating piece's 4 is pasted up to the supporter 3 on the base section 8. The fixed-end section and the opposite side of the piezo-electric oscillating piece 4 are floated, and the attempt which is going to ease stress also occurs as shown in the arrow.

[0014] However, since adhesives 9 will be applied even to the upper surface side of the piezo-electric oscillating piece 4 of drawing 20 in this case, the product size becomes thick and serves as small [ of a product ], and an obstacle of thin-shape-izing.

[0015] Moreover, configurations, such as a supporter, are devised and a device which raises a bond strength is also tried so that the amount of the adhesives to apply may be made [ many ] unlike these and adhesives may not short-circuit electrodes in that case. There are JP,4-119126,U, JP,7-74576,A, JP,7-240653,A, JP,5-48369,A, etc. in this kind of technology. It is made to miss these adhesives in this, so that Slots 3b and 3b may be formed in the upper surface of a susceptor 3, the side slots 3a and 3a may be formed further and the adhesives applied so much may not short-circuit electrodes 6 and 6 as JP,5-48369,A shows to drawing 21.

[0016] However, in order [ these ] to miss adhesives, when a slot etc. is formed like, stress concentration tends to happen structurally and the portion has risk of the rapid temperature rise in the case of closure breaking.

[0017] It aims at offering the piezoelectric transducers and piezo oscillators which do not need a complicated manufacturing process which causes elevation of cost, and these manufacture methods while this invention was



made in order to solve an above-mentioned technical problem, it is excellent in shock-proof ability and moreover holds down resistance low.

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## MEANS

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[Means for Solving the Problem] For this reason, the piezoelectric transducer of invention of a claim 1 has the piezo-electric oscillating piece by which fixed support was carried out with the electric conduction adhesives of a silicon system to the supporter which prepared the polar zone in the front face, and the polar zone formed in this supporter, and is hardened by carrying out temperature up heating in the state of the temperature up which the distribution of the conductive particle which the aforementioned silicon system electric conduction adhesives contain in adhesives from predrying to a predetermined curing temperature solidifies in the uniform state.

[0019] According to the composition of a claim 1, temperature up heating of the distribution of the conductive particle which the electric conduction adhesives of the silicon system which pastes up a supporter and a piezo-electric oscillating piece contain in adhesives from predrying to a predetermined curing temperature is carried out in the state of the temperature up solidified in the uniform state. Here, this invention person etc. found out that the heating up time and resistance for hardening of the electric conduction adhesives of a silicon system had the next relation.

[0020] In the process of hardening, when the conductive particle which adhesives contain, for example, silver dust, and silicon resin were distributed unevenly and hardened, that resistance rises in the part of the state where silver dust is low, a rough \*\*\*\*\* state, i.e., density, made silicon system electric conduction adhesives clear. That is, in the process of hardening, silicon resin contracts silicon system electric conduction adhesives with evaporation of a solvent. In the process of this contraction, silicon resin carries out the operation which brings in a conductive particle in the contraction direction. For this reason, if the setting time is comparatively long, it will concentrate near the center of adhesives and a conductive particle will be solidified in the densities of a surrounding resin, or the state where it waited.

[0021] Then, the hardening heating up time of silicon system electric conduction adhesives is measured beforehand, and it is made to harden by such heating up time so that there may be no such thing. Thereby, while suppressing the rise of resistance, a required bond strength is obtained.

[0022] According to invention of a claim 2, in the composition of a claim 1, it constitutes so that temperature up heating of the aforementioned silicon system electric conduction adhesives may be carried out by four Centigrade or more almost per minute from predrying to a predetermined curing temperature.

[0023] in order to acquire the effect of a claim 1 according to the composition of a claim 2, the heating up time checked [ person / this invention ] is 4 or more degree of Centigrade almost per minute to a desirable curing temperature predetermined from predrying

[0024] According to invention of a claim 3, in the composition of claims 1 or 2, it constitutes so that temperature up heating of the aforementioned silicon system electric conduction adhesives may be carried out by 7.5 Centigrade almost per minute from predrying to a predetermined curing temperature.

[0025] in order to acquire the effect of a claim 1 according to the composition of a claim 3, a heating up time applicable to the various quality of an adhesion facing is Centigrade 7.5 degree almost per minute to a desirable curing temperature predetermined from predrying

[0026] Moreover, according to invention of a claim 4, in the composition of a claim 1 or either of 3, all the adhesion sides of the aforementioned piezo-electric oscillating piece and the aforementioned supporter to paste up consist of aforementioned polar zone.

[0027] According to the composition of a claim 4, bond strength sufficient also as a field in which the electrode is formed in the whole of the adhesion side by stiffening silicon system electric conduction adhesives on condition that a claim 1 or 3 is obtained. Moreover, for this reason, resistance cannot be unnecessarily raised from a bird clapper as it is unnecessary to narrow the polar zone superfluously, and resistance can be held down sufficiently low.

[0028] According to invention of a claim 5, in a claim 1 or the composition of 4, the aforementioned polar zone is formed with gold or silver.

[0029] According to the composition of a claim 5, compared with other materials, resistance can be held down low, and efficient equipment can consist of using the polar zone as gold (Au) or silver (Ag). a programming rate [ in / a hardening process / as shown in drawing 22 here / in silicon system electric conduction adhesives ] -- usual conditions like Centigrade 2 or about 3 times per minute -- setting -- a relation with the quality of the material of an adhesion side -- hardening reaction time -- things -- \*\* In this case, since a hardening heating up time can be stiffened in short time also to the adhesion side which becomes with gold (Au) or silver (Ag) by considering as the conditions of a claim 1 or either of 4 unlike drawing 22, adhesives harden unevenly also as such an adhesion side, and resistance is not raised.

[0030] Moreover, it is constituted so that the aforementioned silicon system electric conduction adhesives may be applied to the field between the aforementioned base and a piezo-electric oscillating piece and invention of a



claim 6 may not be applied to the field where the base of a piezo-electric oscillating piece is opposite in a claim 1 or the composition of 5.

[0031] Moreover, the base section by which the electric conduction pattern was formed in the front face if it was in invention of a claim 7, As opposed to the supporter which has been arranged on this base section and prepared the polar zone in the front face, and the polar zone formed in the aforementioned supporter It has the piezo-electric oscillating piece by which fixed support was carried out with the electric conduction adhesives of a silicon system, and the integrated circuit electrically connected with the electric conduction pattern of the aforementioned base section. the aforementioned silicon system electric conduction adhesives from predrying to a predetermined curing temperature It is the piezo oscillator hardened by carrying out temperature up heating in the state of the temperature up which the distribution of the conductive particle contained in adhesives solidifies in the uniform state.

[0032] According to the composition of a claim 7, it becomes possible to give sufficient bond strength, without raising resistance about the electric conduction adhesives of a silicon system by the same principle as the case of a claim 1.

[0033] According to invention of a claim 8, in the composition of a claim 7, temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by four Centigrade or more almost per minute from predrying to a predetermined curing temperature.

[0034] According to invention of a claim 9, in the composition of claims 7 or 8, temperature up heating of the aforementioned silicon system electric conduction adhesives is carried out by 7.5 Centigrade almost per minute from predrying to a predetermined curing temperature.

[0035] According to invention of a claim 10, in a claim 7 or the composition of 9, all the adhesion sides of the aforementioned piezo-electric oscillating piece and the aforementioned supporter to paste up consist of aforementioned polar zone.

[0036] According to invention of a claim 11, in a claim 7 or the composition of 10, the aforementioned jointing is formed with gold or silver.

[0037] According to invention of a claim 12, the aforementioned silicon system electric conduction adhesives are applied to the field between the aforementioned base and a piezo-electric oscillating piece, and the base of a piezo-electric oscillating piece is a piezo oscillator constituted so that it may not be applied to an opposite field.

[0038] According to invention of a claim 13, in the manufacture method of a piezoelectric transducer equipped with the process which fixes a piezo-electric oscillating piece with the electric conduction adhesives of a silicon system, the distribution of the conductive particle which the aforementioned silicon system electric conduction adhesives contain in adhesives from predrying to a predetermined curing temperature is equipped with the hardening process by which temperature up heating is carried out in the state of the temperature up solidified in the uniform state to the polar zone formed in the supporter made from a ceramic.

[0039] According to the composition of a claim 13, the piezoelectric transducer equipped with the operation by the claim 1 can be manufactured suitably.

[0040] As opposed to the polar zone which according to invention of a claim 14 formed the supporter made from a ceramic in this base section, one, or another object at the base section made from a ceramic by which the electric conduction pattern was formed in the front face, and was formed in the supporter made from this ceramic In the manufacture method of a piezo oscillator equipped with the process which fixes a piezo-electric oscillating piece with the electric conduction adhesives of a silicon system the aforementioned silicon system electric conduction adhesives from predrying to a predetermined curing temperature In the state of the temperature up solidified in the uniform state, the distribution of the conductive particle contained in adhesives is equipped with the hardening process which carries out temperature up heating.

[0041] According to the composition of a claim 14, the piezo oscillator equipped with the operation by the claim 6 can be manufactured suitably.

[0042]

[Embodiments of the Invention] Hereafter, the gestalt of suitable operation of this invention is explained, referring to a drawing.

[0043] Drawing 1 or drawing 12 shows the manufacture process of the piezo oscillator concerning the operation gestalt of this invention, by explaining the process one by one, is united and explains the composition.

[0044] For drawing 1, the plan of the first process and drawing 2 are [ a bottom plan view and drawing 4 of the A-A cross section and drawing 3 ] the right lateral views of drawing 1.

[0045] In these drawings, on the base section 11 which is a plate made from a ceramic, the supporter material 12, 13, and 14 made from a ceramic carried out the laminating, and fixed one by one, and the metal seal ring 15 has fixed by silver soldering in the periphery section of the supporter material 14 further. The whole lower unit of a piezo-electric radiator is called base 40 here, and suppose this base 40 that the whole thing which carried out the laminating of the supporter material 12, 13, and 14, and fixed on the above-mentioned base section 11 is put. And although this base 40 fixed the supporter material of above another objects in the base section 11, it may form the whole with the ceramic material of the base section 11 and one etc., without using others and supporter material.

[0046] The electric conduction pattern 16 with which the integrated circuit later mentioned near [ the ] a center is laid and fixed is formed in the upper surface of the base section 11 as shown in drawing 1. The electric



conduction pattern of this operation gestalt makes electric resistance small, and is formed with the gold (Au) which cannot do an oxide film easily. Specifically, the tungsten was printed upwards, electrolysis plating of the nickel (nickel) is carried out, further, in 0.5 or thickness of 1.27 micrometers, electrolysis plating is carried out and gold is constituted. Here, nickel plating is performed for increasing a golden bond strength. Moreover, although corrosion resistance falls a little rather than gold, you may form an electric conduction pattern with silver (Ag) for the same reason as gold.

[0047] The electric conduction pattern 21 is formed in the background of the base section 11, and it connects with the exterior at it as shown in drawing 3.

[0048] As shown in drawing 2, the supporter material 12 which fixes on the base section 11 is made into a configuration which forms the space S1 of a size in which the integrated circuit mentioned later inside can be held. The electric conduction patterns 17 and 18 with which wirebonding of the end-connection child of the above-mentioned integrated circuit should be carried out are formed in the upper surface of this supporter material 12. Moreover, the supporter material 13 is made into the configuration which forms space S2 in the interior. In drawing of this supporter material 13, as shown in drawing 1, the polar zone 19 and 20 formed by the electric conduction pattern by gold plate etc. is formed in the right-hand side upper surface. Furthermore, the supporter material 14 is made into a configuration which forms space S3 inside, and the above-mentioned seal ring 15 has fixed in the periphery section of the upper surface of this supporter material 14.

[0049] Next, as shown in drawing 5 and drawing 6, an integrated circuit 23 is fixed by die bonding etc. with adhesives 26 on the electric conduction pattern 16 of the base section 11. The integrated circuit 23 is held in space S1 as shown in drawing 6.

[0050] Subsequently, wirebonding of each electric conduction patterns 17 and 18 which correspond with the end-connection child 25 of an integrated circuit 23 is carried out to drawing 7 and drawing 8 by the gold streak 24, and it connects with them electrically as shown. The connected gold streak 24 is held in space S2 as illustrated.

[0051] Next, as shown in drawing 9 and drawing 10, a piezo-electric oscillating piece is fixed to the supporter material 13. In this case, the piezo-electric oscillating piece consists of crystal oscillating pieces 27 using crystal. An electrode 28 and an electrode 29 as shown in drawing 9 are beforehand formed in this crystal oscillating piece 27 of vacuum evaporation etc. In drawing 9, in the edge of the cross direction of the crystal oscillating piece 27, it turns and each electrodes 28 and 29 are formed so that a background may be followed. That is, in drawing 10, it is continuously formed so that it may expose to the right end subordinate side of the crystal oscillating piece 27.

[0052] And as shown in drawing 9 and drawing 10, as the silicon system electric conduction binders 31 and 32 are applied on each polar zone 19 and 20 of the supporter material 13 and the crystal oscillating piece 27 is laid on it, the silicon system electric conduction binders 31 and 32 are stiffened, and it fixes. Therefore, all the adhesion sides of the supporter material 13 and the crystal oscillating piece 27 are polar zone in this case.

[0053] Moreover, it can avoid applying the silicon system electric conduction binders 31 and 32 to the upper surface of the crystal oscillating piece 27 which is the field of an opposite side in the supporter material 13 preferably. By considering as such structure, thickness of a product can be made thin. And since the amount of the adhesives to be used can be lessened, it can prevent changing the property of a piezoelectric transducer by the gas which occurs from adhesives.

[0054] Here, FA-730 of FUJIKURA KASEI CO., LTD. were used for the silicon system electric conduction binders 31 and 32. These adhesives consist of silver dust of an unfixed configuration, and silicon resin and an aromatic system hydrocarbon system solvent as a conductive particle, and the composition is a weight ratio and is 17.7% of silicon resin, 71.0% of silver dust, and 11.3% of solvents.

[0055] Moreover, a silicon system electric conduction binder can use suitably 3303 made from other, for example incorporated company, three bond [above], and the TSE3212 grade of Toshiba Silicone.

[0056] Dryness and hardening of the silicon system electric conduction binders 31 and 32 were performed in the process shown in drawing 13 using the belt furnace. First, as predrying, the temperature up of the ambient temperature is carried out to 65-degree Centigrade, at 65-degree Centigrade or 75 degrees, heating is carried out for about 20 minutes (plus 5-minute minus 0 minute), and a solvent is volatilized enough. Next, a temperature up is carried out to 190 or less degrees 180 degrees or more at the temperature up speed for /7.5-degree Centigrade, and heating was carried out for about 60 minutes (plus 5-minute minus 0 minute), and it was made to have considered belt speed as a part for about 9mm/, and to harden.

[0057] This hardening process is important especially in this operation gestalt. Silicon system electric conduction adhesives can do the conditions which a conductive particle hardens in the state of existing in homogeneity mostly, in silicon resin because it is contingent [on a fixed heating up time] to a curing temperature after above-mentioned predrying. While being able to obtain the suitable flow performance by this, when a mechanical strength equalized, it became clear that a sufficiently strong bond strength is obtained.

[0058] Moreover, bond strength sufficient as an adhesion side, by adopting such a hardening process when the polar zone is used as mentioned above is obtained. That is, polar zone 19 and 20 is based on gold or silver as mentioned above, and plating processing is carried out. If adhesives like this operation gestalt are used only on condition that usual when such an electrode side is made into an adhesion side, as drawing 22 explained, the reaction time in an interface will become comparatively long. And if a hardening reaction takes-a-long time, a



conductive particle will be led to the center of adhesives and density will become thin in an interface. However, since the process stiffened in the above short heating up times was established after predrying, a hardening reaction rate can be brought forward at the hardening process of this operation gestalt also as an adhesion side, and it can be made to harden the above electrode sides, after the conductive particle has existed uniformly in silicon resin. It is possible to obtain bond strength sufficient with a small amount of adhesives, without taking the structure where the means which misses fluids, such as a slot, to a supporter is formed like before, and the short circuit of polar zone 19 and 20 is avoided by this. And flow performance sufficient by using all adhesion sides as an electrode can be obtained, and it is possible to lower resistance enough from a good thing in respect of the electrode of gold or silver especially. And like before, the part and polar zone which do not form the means of the slot on the supporter etc. can secure sufficient area, and can obtain the flow function which was excellent also in this point. Moreover, since external force etc. has not established the structurally weak part which carries out stress concentration in a hoe \*\*\*\*\* case in order not to form the means of a slot etc. in supporter material, a product strong against the part structure target is obtained. Moreover, a product with the small size of the part cross direction is obtained by not forming the means of a slot etc. in supporter material in this way. Here, as a result of this invention person's etc. trying the heating up time after this predrying variously, when obtaining sufficient low resistance and a sufficient bond strength, it was checked per minute as a heating up time (programming rate) that four Centigrade or more is required in the range of dispersion on the quality of a silicon system electric conduction binder. Moreover, especially as this heating up time, it was five Centigrade or more per minute, and in the effect, it could consider as the range of the tolerance which is satisfactory practically, and the result most stabilized in 7.5 Centigrade per minute was obtained. In addition, although the earlier one is desirable, the temperature up speed of ten or less Centigrade is suitable [ from the present technical restrictions ] about the programming rate, per minute as an upper limit.

[0059] Next, as it heats by 200-degree Centigrade for about 2 hours, the crystal oscillating piece 27 is aged and it is shown in drawing 11 and drawing 12, it closes by stationing and carrying out the seam welding of the cap 35 made from covar who performed nickel plating beforehand on a seal ring 15, and a piezo oscillator 10 is completed.

[0060] Drawing 14 is the outline cross section showing the operation gestalt of the piezoelectric transducer of this invention, and since the part which attached the same sign as having used it in explanation of the above-mentioned piezo oscillator 10 is the almost same composition, the overlapping explanation is omitted and is hereafter explained focusing on difference.

[0061] In drawing, as the piezoelectric transducer 50 has the piezo-electric oscillating piece 27 fixed to the supporter material 13 and 14 and this supporter material 14 made from the ceramic which fixed one by one on the base section 11 which becomes by the substrate made from a ceramic, and this base section 11 and covers this piezo-electric oscillating piece 27, through the seal ring 15, it stations a cap 35, closes and is formed on the supporter material 13.

[0062] And the supporter 13 and the piezo-electric oscillating piece 27 are pasted up with the ceramic system electric conduction adhesives 31 and 32 according to the same process as the piezo oscillator 10 mentioned above.

[0063] Thereby, also in this piezoelectric transducer 50, the completely same effect as the piezo oscillator 10 mentioned above can be acquired.

[0064] In addition, the supporter material 13 and 14 may be constituted by the base section 11 and one by the same material.

[0065] About the piezoelectric transducer 50 constituted according to each above-mentioned operation gestalt, in order to check the resistance, the result which measured CI value is shown in drawing 15.

[0066] Using the terminal electrode of the end face of the base section 11, drawing 15 impresses drive current, changes the power from 0.01microW to 100microW, measures CI value of 41 places, and shows deltaCI which becomes drawing 15 (a) at the CI maximum minus CI minimum value about a maximum CI value at drawing 15 (b). In the case of the piezoelectric transducer 50 manufactured by the above-mentioned method, the thing of low resistance was able to be obtained enough.

[0067] Moreover, drawing 16 and drawing 17 performed the drop test for investigating the shock resistance about the piezoelectric transducer 50 constituted according to the above-mentioned operation gestalt. Drawing 16 measured CI value before fall, and CI value after fall in each fall height of a horizontal axis, sample each was asked for the difference and CI value was measured with 100microW drive current. Drawing 17 measures how much after the frequency of the product before fall falling, it changed in each fall height of a horizontal axis.

[0068] Thus, in the piezoelectric transducer 50 by this operation gestalt, it has the shock resistance excellent not only in the mechanical strength but the performance side about shock resistance.

[0069] In addition, the property about the above-mentioned piezoelectric transducer 50 cannot be overemphasized by the same thing in a piezo oscillator 10.

## DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the outline plan showing the process of the beginning of the manufacturing process of the



piezo oscillator by the operation gestalt of this invention.

[Drawing 2] It is the outline sectional side elevation of the process of drawing 1 .

[Drawing 3] It is the outline bottom plan view of the process of drawing 1 .

[Drawing 4] It is the outline right lateral view of the process of drawing 1 .

[Drawing 5] It is the outline plan of the process following the process of drawing 1 .

[Drawing 6] It is the outline cross section of the process of drawing 5 .

[Drawing 7] It is the outline plan of the process following the process of drawing 5 .

[Drawing 8] It is the outline cross section of the process of drawing 7 .

[Drawing 9] It is the outline plan of the process following the process of drawing 7 .

[Drawing 10] It is the outline side elevation of the process of drawing 9 .

[Drawing 11] It is the outline plan of the process of the last of the manufacturing process of the piezo oscillator of this operation gestalt, and the whole piezo-oscillator composition is shown.

[Drawing 12] It is the outline sectional side elevation of the process of drawing 11 , and the whole piezo-oscillator composition is shown.

[Drawing 13] In the process of drawing 9 and drawing 10 , it is drawing explaining the hardening process of adhesives.

[Drawing 14] It is the outline cross section showing the example of composition of the piezoelectric transducer in the operation gestalt of this invention.

[Drawing 15] It is drawing showing CI value of the piezoelectric transducer in the operation gestalt of this invention.

[Drawing 16] It is drawing showing the result of the drop test of the piezoelectric transducer in the operation gestalt of this invention.

[Drawing 17] It is drawing showing the result of the drop test of the piezoelectric transducer in the operation gestalt of this invention.

[Drawing 18] It is the outline perspective diagram showing an example of the composition of the conventional piezoelectric transducer.

[Drawing 19] It is drawing showing the kind of adhesives, and the relation of a bond strength.

[Drawing 20] It is the outline front view showing the example of composition of a piezoelectric transducer.

[Drawing 21] It is the outline perspective diagram showing the example of composition of a piezoelectric transducer.

[Drawing 22] It is drawing showing the relation between the kind of field for adhesion of adhesives, and hardening reaction time.

[Description of Notations]

10 Piezo Oscillator

11 Base Section

12 Supporter Material

13 Supporter Material

14 Supporter Material

15 Seal Ring

19 Polar Zone

20 Polar Zone

23 Integrated Circuit

27 Crystal Oscillating Piece (Piezo-electric Oscillating Piece)

31 Silicon System Electric Conduction Adhesives

32 Silicon System Electric Conduction Adhesives

35 Cap

40 Base

50 Piezoelectric Transducer



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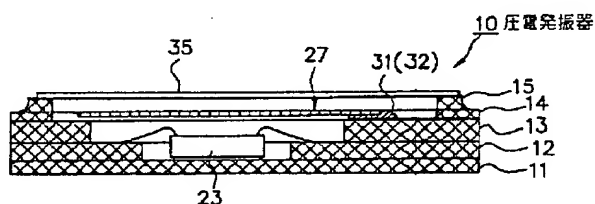
HA05

(54) 【発明の名称】 圧電振動子と圧電発振器及びこれらの製造方法

(57) 【要約】

【課題】 耐衝撃性能に優れ、しかも抵抗値を低く抑えるとともに、コストの上昇を招くような複雑な製造工程を必要としない圧電振動子及び圧電発振器とこれらの製造方法を提供すること。

【解決手段】 支持部13に形成された電極部19、20に対して、シリコン系の導電接着剤31、32により固定支持された圧電振動片27を有している。このシリコン系導電接着剤31、32は、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱することにより硬化されている。



## 【特許請求の範囲】

【請求項 1】 表面に電極部を設けたベースと、このベースに形成された電極部に対して、シリコン系の導電接着剤により固定支持された圧電振動片とを有しており、

前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱することにより硬化されていることを特徴とする、圧電振動子。

【請求項 2】 前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏 4 度以上にて昇温加熱される請求項 1 に記載の圧電振動子。

【請求項 3】 前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏 7.5 度にて昇温加熱される請求項 1 または 2 に記載の圧電振動子。

【請求項 4】 前記圧電振動片と接着される前記ベースの接着面が全て前記電極部で構成されている請求項 1 ないし 3 のいずれかに記載の圧電振動子。

【請求項 5】 前記電極部が金または銀により形成されている請求項 1 ないし 4 のいずれかに記載の圧電振動子。

【請求項 6】 前記シリコン系導電接着剤が、前記ベースと圧電振動片との間の領域に塗布され、圧電振動片のベースとは反対の面に適用されないように構成されている請求項 1 ないし 5 のいずれかに記載の圧電振動子。

【請求項 7】 表面に所定の導電パターンと電極部とを設けたベースと、

前記ベースの導電パターンと電氣的に接続固定された集積回路と前記ベースに形成された電極部に対して、シリコン系の導電接着剤により固定支持された圧電振動片と、を有しており、

前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱することにより硬化されていることを特徴とする、圧電発振器。

【請求項 8】 前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏 4 度以上にて昇温加熱される請求項 7 に記載の圧電発振器。

【請求項 9】 前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏 7.5 度にて昇温加熱される請求項 7 または 8 に記載の圧電発振器。

【請求項 10】 前記圧電振動片と接着される前記ベースの接着面が全て前記電極部で構成されている請求項 7 ないし 9 のいずれかに記載の圧電発振器。

【請求項 11】 前記電極部が金または銀により形成されている請求項 7 ないし 10 のいずれかに記載の圧電発振器。

【請求項 12】 前記シリコン系導電接着剤が、前記ベースと圧電振動片との間の領域に塗布され、圧電振動片のベースとは反対の面に適用されないように構成されて

いる請求項 7 ないし 11 のいずれかに記載の圧電発振器。

【請求項 13】 セラミック製のベースに形成された電極部に対して、シリコン系の導電接着剤により圧電振動片を固定する工程を備える圧電振動子の製造方法において、

前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱される硬化工程を備えることを特徴とする、圧電振動子の製造方法。

【請求項 14】 表面に導電パターンが形成されたセラミック製のベース部にこのベース部と一体もしくは別体にセラミック製の支持部を設け、

このセラミック製の支持部に形成された電極部に対して、シリコン系の導電接着剤により圧電振動片を固定する工程を含む圧電発振器の製造方法において、

前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱する硬化工程を備えることを特徴とする、圧電発振器の製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、圧電振動片を利用して構成する圧電振動子と、この圧電振動子を搭載した圧電発振器の改良に関するものである。

【0002】

【従来の技術】従来、このような圧電振動子は例えば図 18 に示すように構成されている。

【0003】図において、圧電振動子 1 は、セラミック製のベース部 8 の上面に、導電パターン 2 を形成し、その上に銀ペーストにて固定された支持台 3 を備えている。この支持台 3 の上面には電極 7、7 が形成されており、支持台 3 の上面には、圧電振動片 4 が固定されている。圧電振動片 4 には、外部電極 6、6 が設けられており、この電極 6、6 は、支持台 3 の電極 7、7 を介して、ベース部 8 の上記導電パターン 2 と電氣的に接続されており、この導電パターン 2 は、ベース部 8 の裏側に導かれ、外部と接続されている。そして、圧電振動片 4 を上から覆うように、キャップ 5 が被せられることにより、封止されている。

【0004】このような圧電振動子 1 によれば、外部から所定の駆動電流を与えられることにより、圧電振動片 4 が固有の振動数にて振動し、これを電氣的に取り出すことにより、所定の周波数の電流を得ることができる。これを所定の発振回路と組み合わせることで、コンピュータのクロック信号や時計の基準クロック等を得ることができる。

【0005】そして、上述の圧電振動子を集積化された発振回路等とを組み合わせた圧電発振器も広く利用されている。

【0006】

【発明が解決しようとする課題】ところで、上述のような圧電振動子 1 にあっては、ベース部 8 または支持台 3 に対して、圧電振動片 4 を電気的な導通を保持して固定するために、導電性接着剤が用いられている。

【0007】このような導電性接着剤としては、シリコン樹脂と導電性の銀粉及び溶剤でなるものが広く利用されている。このような接着剤を用いることで、導通を確保しつつ簡易に接着固定が行われる。

【0008】しかしながら、図 19 に示すように、シリコン系の接着剤は、他の接着剤と比較すると、接着強度が弱いことから、製品に必要な機械的強度を得るために、種々の工夫が行われている。

【0009】例えば、特開平 8-139426 号によれば、圧電振動片を構成する水晶チップの露出部を大きくしたり、ベース部の露出部を大きくして、これら露出部が接着剤による接着面の一部を構成するようにしている。これによると、電極部のみに接着剤を適用して接着する場合に比して、接着強度を向上させることができる。

【0010】ところが、このようにすると、必然的に圧電振動片に形成すべき電極部の面積が小さくなる。このため、駆動電力が 0.01  $\mu$ W 程度と小さくなってくると、水晶製の圧電振動片 4 の等価直列抵抗値（クリスタルインピーダンス）、（以下、「CI 値」と言う）が大きくなり、水晶振動片 4 が振動しにくくなる。すなわち、圧電振動子のドライブレベルが悪化する欠点がある。したがって、電極部を狭くしたまま、ドライブレベルを向上させようすると、電極部を形成する電極膜を厚くする必要が生じる。

【0011】ここで、電極膜を厚くしようすると、電極形成時間が長くなり、高価なターゲット材や蒸着源を多量に消費することとなって、製造コストが上昇してしまう。また、製品を小型化する上では、水晶振動片の搭載精度や接着位置の位置決め精度の向上、接着剤の適正な分量管理等、別の多くの課題を解決する必要性が生じてしまう。

【0012】また、上記とは別の方法として、例えば、特開平 2-75214 号や実開平 5-25822 号に開示されているように、水晶振動片を接着する際に、シリコン系導電接着剤だけでなく、他の接着強度の高い接着剤を使用して、足りない接着強度を補う方法も考えられる。ところが、このように複数種類の接着剤を使用すると、その分製造工程が複雑となり、工数の増加から製造コストの上昇を招く欠点がある。

【0013】これに対して、例えば特許第 2668585 号によれば、図 20 に示すように、ベース部 8 上の支持部 3 に対して、圧電振動片 4 を接着する際に、接着剤 9 を圧電振動片 4 の支持部 3 とは反対側の面にまで適用し、これによって、接着剤 9 が硬化する過程で収縮する

ことで、矢印に示されているように、圧電振動片 4 の固定端部と反対側を浮かせ、応力を緩和しようとする試みもある。

【0014】しかし、この場合には、接着剤 9 は、図 20 の圧電振動片 4 の上面側にまで適用されてしまうため、その製品サイズが厚くなってしまい、製品の小型、薄型化の障害となる。

【0015】また、これらとは異なり、塗布する接着剤の量を多くして、その場合に接着剤が電極どうしを短絡しないように、例えば支持部等の形状を工夫して、接着強度を高めるような工夫も試みられている。この種の技術には、実開平 4-119126 号や、特開平 7-74576 号、特開平 7-240653 号、特開平 5-48369 号等がある。このなかで、特開平 5-48369 号では、図 21 に示すように、支持台 3 の上面に溝 3b、3b を形成し、さらに側面溝 3a、3a を形成して、多量に適用した接着剤が電極 6、6 を短絡することがないように、この接着剤を逃がすようにしている。

【0016】しかしながら、これらのように、接着剤を逃がすために、溝等を形成すると、その部分は、構造的に応力集中が起こりやすく、封止の際の急激な温度上昇によって破壊される危険がある。

【0017】この発明は、上述の課題を解決するためになされたもので、耐衝撃性能に優れ、しかも抵抗値を低く抑えるとともに、コストの上昇を招くような複雑な製造工程を必要としない圧電振動子及び圧電発振器とこれらの製造方法を提供することを目的としている。

【0018】

【課題を解決するための手段】このために、請求項 1 の発明の圧電振動子は、表面に電極部を設けた支持部と、この支持部に形成された電極部に対して、シリコン系の導電接着剤により固定支持された圧電振動片とを有しており、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱することにより硬化されている。

【0019】請求項 1 の構成によれば、支持部と圧電振動片とを接着するシリコン系の導電接着剤が予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱されている。ここで、本発明者等は、シリコン系の導電接着剤の硬化のための昇温時間と抵抗値とが、次の関係にあることを見いだした。

【0020】シリコン系導電接着剤は、硬化の過程において、接着剤が含有する導電性粒子、例えば銀粉とシリコン樹脂とが不均一に分布して硬化すると、銀粉が粗になった状態、つまり密度が低い状態の箇所にて抵抗値が上昇することが判明した。つまり、シリコン系導電接着剤は、硬化の過程において、溶剤の気化とともにシリコン樹脂が収縮する。この収縮の過程において、シリコン

樹脂は導電性粒子を収縮方向に引っ張り込む作用をする。このため、比較的硬化時間が長いと、導電性粒子は、接着剤の中心付近に集中し、周囲の樹脂の密度がたかまった状態で固化してしまう。

【0021】そこで、このようなことのないように、シリコン系導電接着剤の硬化昇温時間を予め計測して、そのような昇温時間で硬化させるものである。これにより、抵抗値の上昇を抑えるとともに、必要な接着強度が得られる。

【0022】請求項2の発明によれば、請求項1の構成において、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏4度以上にて昇温加熱されるように構成する。

【0023】請求項2の構成によれば、請求項1の効果を得るために、本発明者等の確認した昇温時間は、好ましくは、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏4度以上である。

【0024】請求項3の発明によれば、請求項1または2の構成において、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏7.5度にて昇温加熱されるように構成する。

【0025】請求項3の構成によれば、請求項1の効果を得るために、種々の接着面材質に適用可能な昇温時間は、好ましくは、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏7.5度である。

【0026】また、請求項4の発明によれば、請求項1ないし3のいずれかの構成において、前記圧電振動片と接着される前記支持部の接着面が全て前記電極部で構成されている。

【0027】請求項4の構成によれば、請求項1ないし3の条件にてシリコン系導電接着剤を硬化させることで、その接着面を全て電極が形成されている面としても、十分な接着強度が得られる。また、このために、不必要に電極部を狭くすることが不要となることから、無用に抵抗値を高めることがなく、抵抗値を十分低く抑えることができる。

【0028】請求項5の発明によれば、請求項1ないし4の構成において、前記電極部が金または銀により形成されている。

【0029】請求項5の構成によれば、電極部を金(Au)または銀(Ag)とすることで、他の材料と比べて抵抗値を低く抑えることができ、効率よい装置を構成できる。ここで、図22に示されているように、シリコン系導電接着剤は、硬化工程における昇温速度が毎分摂氏2ないし3度程度のような通常の条件においては、接着面の材質との関係で硬化反応時間がことなる。この場合、硬化昇温時間を請求項1ないし4のいずれかの条件とすることで、金(Au)または銀(Ag)でなる接着面に対しても、図22と異なり、短い時間で硬化させることができるので、このような接着面としても、接着剤

が不均一に硬化して抵抗値を上昇させることがない。

【0030】また、請求項6の発明は、請求項1ないし5の構成において、前記シリコン系導電接着剤が、前記ベースと圧電振動片との間の領域に塗布され、圧電振動片のベースとは反対の面に適用されないように構成されている。

【0031】また、請求項7の発明にあっては、表面に導電パターンが形成されたベース部と、このベース部上に配置され、表面に電極部を設けた支持部と、前記支持部に形成された電極部に対して、シリコン系の導電接着剤により固定支持された圧電振動片と、前記ベース部の導電パターンと電気的に接続された集積回路とを有しており、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱することにより硬化されている、圧電発振器である。

【0032】請求項7の構成によれば、請求項1の場合と同一の原理にて、シリコン系の導電接着剤に関して、抵抗値を上昇させることなく、十分な接着強度をもたせることが可能となる。

【0033】請求項8の発明によれば、請求項7の構成において、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏4度以上にて昇温加熱される。

【0034】請求項9の発明によれば、請求項7または8の構成において、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、ほぼ毎分摂氏7.5度にて昇温加熱される。

【0035】請求項10の発明によれば、請求項7ないし9の構成において、前記圧電振動片と接着される前記支持部の接着面が全て前記電極部で構成されている。

【0036】請求項11の発明によれば、請求項7ないし10の構成において、前記接着部が金または銀により形成されている。

【0037】請求項12の発明によれば、前記シリコン系導電接着剤が、前記ベースと圧電振動片との間の領域に塗布され、圧電振動片のベースとは反対の面に適用されないように構成されている圧電発振器である。

【0038】請求項13の発明によれば、セラミック製の支持部に形成された電極部に対して、シリコン系の導電接着剤により圧電振動片を固定する工程を備える圧電振動子の製造方法において、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱される硬化工程を備えている。

【0039】請求項13の構成によれば、請求項1による作用を備えた圧電振動子を好適に製造することができる。

【0040】請求項14の発明によれば、表面に導電パターンが形成されたセラミック製のベース部にこのベー

ス部と一体もしくは別体にセラミック製の支持部を設け、このセラミック製の支持部に形成された電極部に対して、シリコン系の導電接着剤により圧電振動片を固定する工程を備える圧電発振器の製造方法において、前記シリコン系導電接着剤が、予備乾燥から所定の硬化温度まで、接着剤に含有される導電性粒子の分布が均一な状態で固化する昇温状態にて、昇温加熱する硬化工程を備えている。

【0041】請求項14の構成によれば、請求項6による作用を備えた圧電発振器を好適に製造することができる。

【0042】

【発明の実施の形態】以下、本発明の好適な実施の形態を図面を参照しながら説明する。

【0043】図1ないし図12は、本発明の実施形態にかかる圧電発振器の製造過程を示しており、その工程を順次説明することにより、あわせてその構成を説明する。

【0044】図1は、最初の工程の平面図、図2はそのA-A断面図、図3は底面図、図4は図1の右側面図である。

【0045】これらの図において、セラミック製の板状体であるベース部11の上に順次セラミック製の支持部材12、13、14が積層し固着され、さらに支持部材14の周縁部には、金属製のシールリング15が銀ロウ付で固着されている。ここで圧電発振器の下部ユニット全体をベース40といい、このベース40は、上記ベース部11上に支持部材12、13、14を積層して固着したもの全体をさすこととする。そして、このベース40は、ベース部11に上述のような別体の支持部材を固着したもののほか、支持部材を使わずに、その全体をベ

ース部11と一体のセラミック材料等で形成してもよい。

【0046】ベース部11の上面には図1に示されているように、その中心付近に後述する集積回路が載置されて固定される導電パターン16が形成されている。本実施形態の導電パターンは電気抵抗を小さくし、酸化膜ができにくい金(Au)により形成されている。具体的には、タングステンを印刷した上にニッケル(Ni)を電解メッキし、さらに、金を例えば0.5ないし1.27μmの厚さに電解メッキして構成している。ここで、ニッケルメッキを施すのは、金の付着強度を増すためである。また、金よりも耐食性はやや落ちるが、金と同様の理由により、導電パターンは銀(Ag)にて形成してもよい。

【0047】図3に示されているように、ベース部11の裏側には、導電パターン21が形成され、外部と接続されるようになっている。

【0048】図2に示すように、ベース部11上に固着される支持部材12は、内側に後述する集積回路を収容

できる大きさの空間S1を形成するような形状とされている。この支持部材12の上面には、上記集積回路の接続端子がワイヤボンディングされるべき導電パターン17及び18が形成されている。また、支持部材13は、内部に空間S2を形成する形状とされている。この支持部材13の図において右側上面には、図1に示すように、金メッキ等による導電パターンで形成した電極部19及び20が形成されている。さらに、支持部材14は、内側に空間S3を形成するような形状とされており、この支持部材14の上面の周縁部に上述のシールリング15が固着されている。

【0049】次に、図5及び図6に示すように、ベース部11の導電パターン16の上に集積回路23を接着剤26によりダイボンディング等により固定する。集積回路23は、図6に示されているように空間S1内に収容されている。

【0050】次いで、図7及び図8に示されているように、集積回路23の接続端子25と、対応する各導電パターン17及び18とを金線24によりワイヤボンディングし、電気的に接続する。図示されているように、接続された金線24等は空間S2内に収容されている。

【0051】次に、図9及び図10に示すように支持部材13に圧電振動片を固定する。この場合圧電振動片は、例えば水晶を利用した水晶振動片27で構成されている。この水晶振動片27には、予め蒸着等により、図9に示すような電極28と電極29とが形成されている。各電極28と29は、図9において、水晶振動片27の幅方向の端部において、裏側に連続するように回り込んで形成されている。つまり、図10において、水晶振動片27の右端部下面に露出するように連続して形成されている。

【0052】そして、図9及び図10に示すように、シリコン系導電接着材31及び32を支持部材13の各電極部19及び20の上に適用し、その上に水晶振動片27を載置するようにして、シリコン系導電接着材31及び32を硬化させて固定する。したがって、この場合、支持部材13と水晶振動片27の接着面は全て電極部である。

【0053】また、好ましくは、シリコン系導電接着材31及び32を支持部材13とは反対側の面である水晶振動片27の上面に塗布しないようにすることができる。このような構造とすることで、製品の厚みを薄くすることができる。しかも、使用する接着剤の量を少なくすることができるので、接着剤から発生するガスによって、圧電振動子の特性が変動することを防止することができる。

【0054】ここで、シリコン系導電接着材31及び32は、藤倉化成株式会社のFA-730を用いた。この接着剤は、導電性粒子として不定形状の銀粉と、シリコン樹脂、芳香族系炭化水素系溶剤で構成されており、そ

の組成は、重量比で、シリコン樹脂 17、7 パーセント、銀粉 71、0 パーセント、溶剤 11、3 パーセントである。

【0055】また、シリコン系導電接着材は、上記の他、例えば、株式会社スリーボンド製の 3303、東芝シリコンの TSE3212 等を好適に使用することができる。

【0056】シリコン系導電接着材 31 及び 32 の乾燥・硬化は、ベルト炉を用いて、図 13 に示すプロセスにて行った。先ず予備乾燥として、雰囲気温度を摂氏 65 度まで昇温し、摂氏 65 度ないし 75 度で、約 20 分（プラス 5 分マイナス 0 分）加熱して、溶剤を十分揮発させる。次に、ベルトスピードを約 9 mm/分として、摂氏 7.5 度/分の昇温スピードにて、180 度以上 190 度以下まで昇温させ、約 60 分（プラス 5 分マイナス 0 分）加熱して、硬化させた。

【0057】この硬化工程が、本実施形態において特に重要である。上述の予備乾燥後において、硬化温度まで一定の昇温時間を条件とすることで、シリコン系導電接着剤は、導電性粒子が、シリコン樹脂中にほぼ均一に存在する状態で硬化する条件ができる。これにより、好適な導通性能を得ることができるとともに、機械的強度が均一化することにより、十分強い接着強度が得られることが判明した。

【0058】また、このような硬化工程を採用することで、接着面として、上述のように電極部を用いた場合にも、十分な接着強度が得られる。つまり、電極部 19、20 は、上述のように金または銀によるメッキ処理されている。このような電極面を接着面とした場合には、本実施形態のような接着剤を単に通常の条件で用いると、図 22 にて説明したように、境界面での反応時間が比較的長くなってしまふ。そして、硬化反応に長時間を要すると、導電性粒子が接着剤の中心に導かれて、境界面にて密度が薄くなってしまふ。しかしながら、本実施形態の硬化工程には、予備乾燥後に上述のような短い昇温時間にて硬化させる工程を設けたことから、上述のような電極面を接着面としても、硬化反応速度を早めることができ、シリコン樹脂中に導電性粒子が均一に存在した状態で硬化させることができるのである。これによって、従来のように、支持部に溝等の流体を逃がす手段を形成して、電極部 19 と 20 の短絡を避けるような構造をとることなく、少量の接着剤にて十分な接着強度を得ることが可能である。しかも、接着面をすべて電極とすることで、十分な導通性能を得ることができ、特に金や銀の電極面でよいことから、十分抵抗値を下げる事が可能である。しかも、従来のように、支持部の溝等の手段を形成しない分、電極部は十分な面積を確保でき、この点においても優れた導通機能を得ることができる。また、支持部材に溝等の手段を形成しないために、外力等がくわった場合に応力集中する構造的に弱い箇所を設けて

いないから、その分構造的に強い製品が得られる。また、このように、支持部材に溝等の手段を形成しないことにより、その分幅方向の寸法が小さい製品が得られる。ここで、この予備乾燥後の昇温時間は、本発明者等が種々試みた結果、十分な低い抵抗値と接着強度を得る上では、昇温時間（昇温速度）として毎分摂氏 4 度以上が、シリコン系導電接着材の品質上のばらつきの範囲にて必要であることが確認された。また、この昇温時間としては、特に毎分摂氏 5 度以上で、その効果において、実用上問題ない公差の範囲とすることができ、毎分摂氏 7.5 度にて最も安定した結果が得られた。なお、昇温速度については、早い方が好ましいのであるが、現在の技術上の制約から、上限として、毎分摂氏 10 度以下の昇温スピードが適している。

【0059】次に、摂氏 200 度にて 2 時間程度加熱して水晶振動片 27 のエージングを行い、図 11 及び図 12 に示すように、予めニッケルメッキを施したコパール製のキャップ 35 をシールリング 15 の上に配置して、シーム溶接することにより封止を行って、圧電発振器 10 を完成する。

【0060】図 14 は、本発明の圧電振動子の実施形態を示す概略断面図であり、上述の圧電発振器 10 の説明において使用したのと同じ符号を付した箇所はほぼ同じ構成であるから、重複する説明は省略し、以下、相違点を中心に説明する。

【0061】図において、圧電振動子 50 は、セラミック製の基板でなるベース部 11 と、このベース部 11 上に順次固着されたセラミック製の支持部材 13、14 と、この支持部材 14 に固定された圧電振動片 27 とを有しており、この圧電振動片 27 を覆うようにして、支持部材 13 上に、シールリング 15 を介してキャップ 35 を配置して封止して形成されている。

【0062】そして、支持部 13 と圧電振動片 27 は、上述した圧電発振器 10 と同じ工程によりセラミック系導電接着剤 31、32 にて接着されている。

【0063】これにより、この圧電振動子 50 においても、上述した圧電発振器 10 と全く同様の効果を得ることができる。

【0064】尚、支持部材 13、14 は、ベース部 11 と一体に同一の素材により構成されていてもよい。

【0065】上述の各実施形態により構成した圧電振動子 50 について、その抵抗値を確認するために、CI 値を測定した結果が、図 15 に示されている。

【0066】図 15 は、ベース部 11 の端面の端子電極を用いて、駆動電流を印加し、その電力を 0.01  $\mu$ W から、100  $\mu$ W まで変化させて、41 箇所の CI 値を測定し、図 15 (a) に最大 CI 値を、図 15 (b) に CI 最大値マイナス CI 最小値でなる  $\Delta$  CI を示している。上述の方法により製造された圧電振動子 50 の場合、十分低い抵抗値のものを得ることができた。

【0067】また、上述の実施形態により構成した圧電振動子50について、その耐衝撃性を調べるための落下試験を行ったのが、図16及び図17である。図16は、横軸の各落下高さにおいて、落下前のC I値と落下後のC I値を計測して、その差を試料個々に求めたものであって、C I値は100  $\mu$ W駆動電流で計測した。図17は、横軸の各落下高さにおいて、落下前の製品の周波数が落下後にどの程度変化したかを計測したものである。

【0068】このように、本実施形態による圧電振動子50では、耐衝撃性に関して、その機械的強度だけでなく、性能面でも優れた耐衝撃性を備えている。

【0069】尚、上述の圧電振動子50に関する特性は、圧電発振器10においても同様であることは言うまでもない。

【0070】

【発明の効果】以上説明したように、請求項1と請求項7の発明によれば、耐衝撃性能に優れ、しかも抵抗値を低く抑えけるとともに、コストの上昇を招くような複雑な製造工程を必要としない、圧電振動子及び圧電発振器をそれぞれ提供することができる。

【0071】請求項2と請求項8の発明によれば、請求項1と請求項7の効果を得るために、それぞれ好ましい条件を提供することができ、請求項3と請求項9の発明によれば、請求項1と請求項7の効果を得るために、さらに好ましい条件を提供することができる。

【0072】請求項4と請求項10の発明によれば、請求項1または請求項6の効果に加えて、接着強度を損なうことなく導通性能に優れた圧電振動子または圧電発振器を提供することができる。

【0073】請求項5と請求項11の発明によれば、請求項1または請求項6の効果に加えて、接着強度を損なうことなく抵抗値の低い導通性能に優れた圧電振動子または圧電発振器を提供することができる。

【0074】請求項6と請求項12の発明によれば、圧電振動片の上には接着剤がないので、その分厚みが薄い圧電振動子または圧電発振器を提供することができる。

【0075】請求項11と請求項12の発明によれば、十分な接着強度を得ることができ、しかも抵抗値を低く抑えけるとともに、コストの上昇を招くような複雑な製造工程を必要としない圧電振動子及び圧電発振器の製造方法をそれぞれ提供することができる。

【図面の簡単な説明】

【図1】本発明の実施形態による圧電発振器の製造工程の最初の工程を示す概略平面図である。

【図2】図1の工程の概略側断面図である。

【図3】図1の工程の概略底面図である。

【図4】図1の工程の概略右側面図である。

【図5】図1の工程に続く工程の概略平面図である。

【図6】図5の工程の概略断面図である。

【図7】図5の工程に続く工程の概略平面図である。

【図8】図7の工程の概略断面図である。

【図9】図7の工程に続く工程の概略平面図である。

【図10】図9の工程の概略側面図である。

【図11】本実施形態の圧電発振器の製造工程の最後の工程の概略平面図であり、圧電発振器の全体構成を示している。

【図12】図11の工程の概略側断面図であり、圧電発振器の全体構成を示している。

【図13】図9及び図10の工程において、接着剤の硬化工程を説明する図である。

【図14】本発明の実施形態における圧電振動子の構成例を示す概略断面図である。

【図15】本発明の実施形態における圧電振動子のC I値を示す図である。

【図16】本発明の実施形態における圧電振動子の落下試験の結果を示す図である。

【図17】本発明の実施形態における圧電振動子の落下試験の結果を示す図である。

【図18】従来の圧電振動子の構成の一例を示す概略斜視図である。

【図19】接着剤の種類と接着強度の関係を示す図である。

【図20】圧電振動子の構成例を示す概略正面図である。

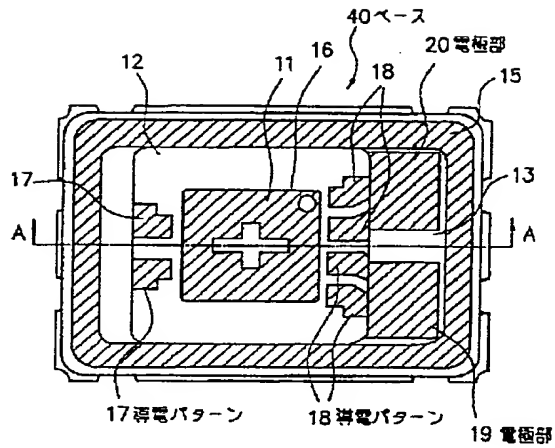
【図21】圧電振動子の構成例を示す概略斜視図である。

【図22】接着剤の接着対象面の種類と硬化反応時間との関係を示す図である。

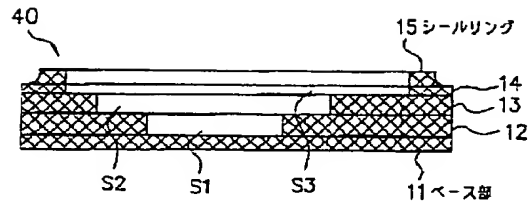
【符号の説明】

10	圧電発振器
11	ベース部
12	支持部材
13	支持部材
14	支持部材
15	シールリング
19	電極部
20	電極部
23	集積回路
27	水晶振動片（圧電振動片）
31	シリコン系導電接着剤
32	シリコン系導電接着剤
35	キャップ
40	ベース
50	圧電振動子

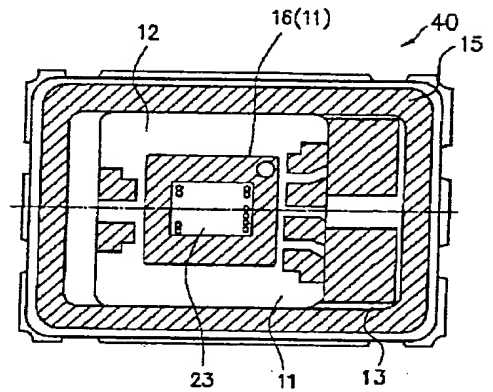
【図 1】



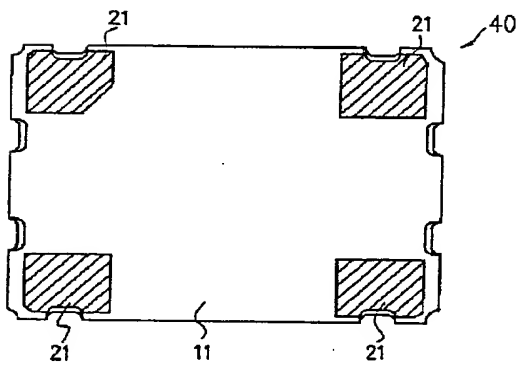
【図 2】



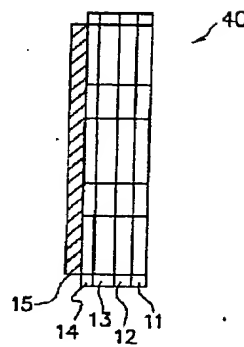
【図 5】



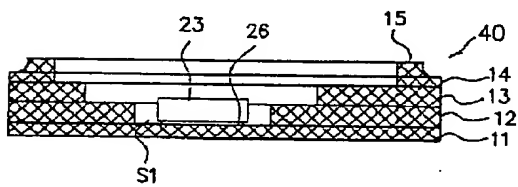
【図 3】



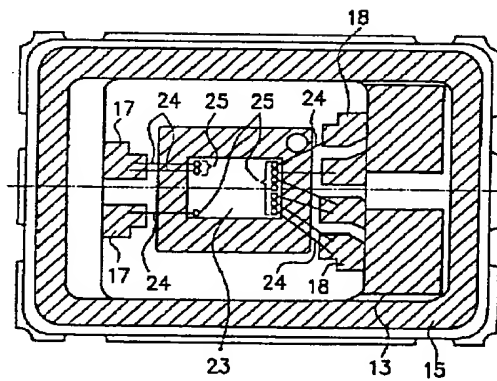
【図 4】



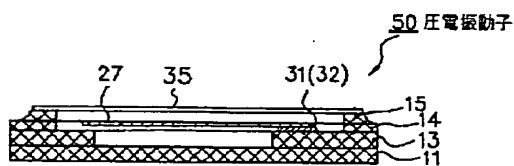
【図 6】



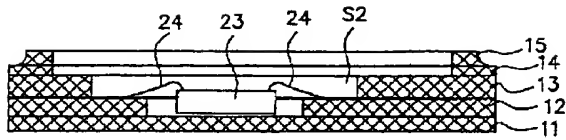
【図 7】



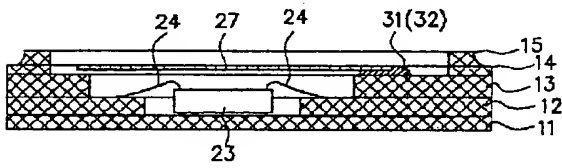
【図 14】



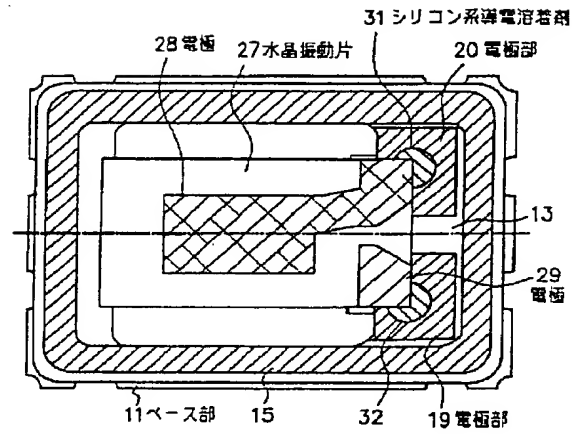
【図 8】



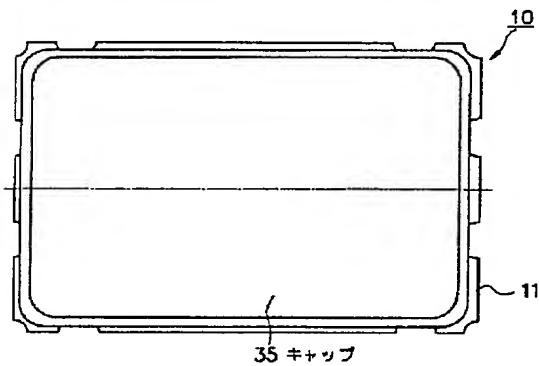
【図 10】



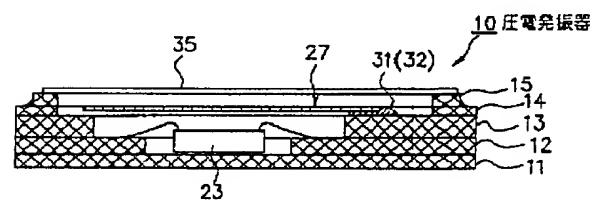
【図 9】



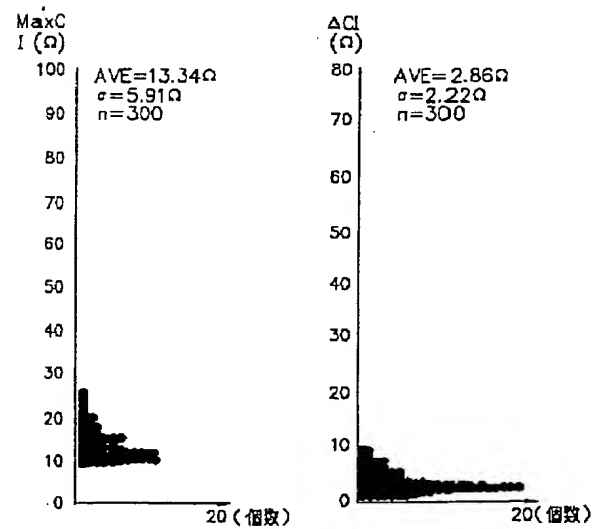
【図 11】



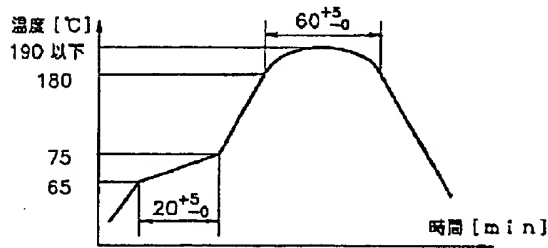
【図 12】



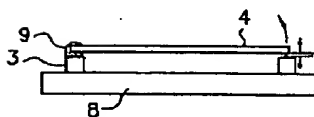
【図 15】



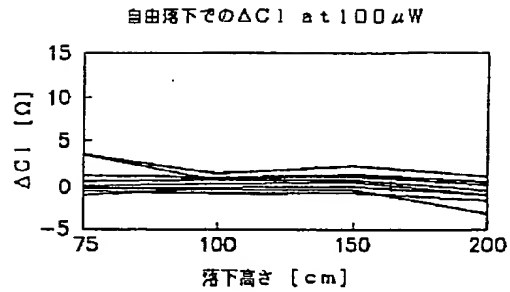
【図 13】



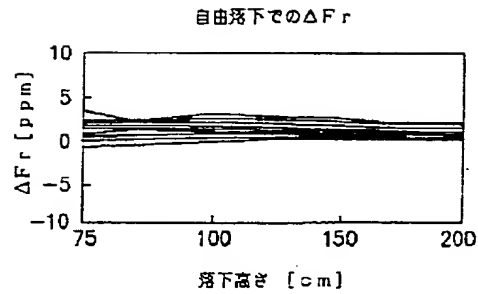
【図 20】



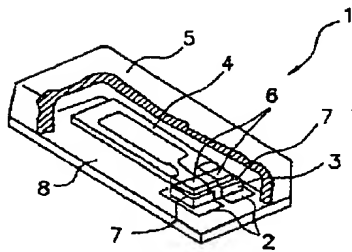
【図16】



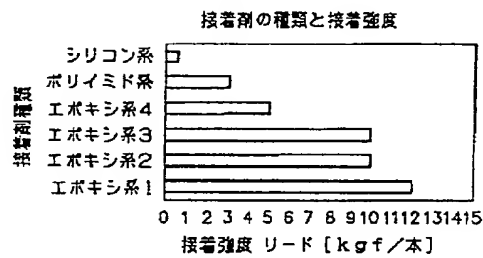
【図17】



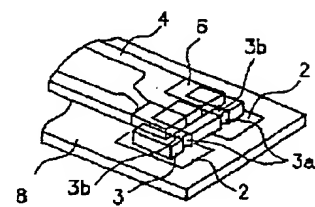
【図18】



【図19】



【図21】



【図22】

